

Patent Claims

1. A method for the parallel manufacturing of a plurality of piezoelectric actuators, in the following process steps:

- manufacturing thin foils (1-3) made of an unfired, piezoelectric ceramic material,
- forming first and second connecting openings (11-16, 17-22) penetrating the foils (1-3), first (11-16) and a second (17-22) connecting opening being assigned to each actuator,
- coating one surface (4) of each of the foils (1-3) with a plurality of electrodes (5-10), at least one electrode (5-10) being assigned to each actuator in each foil (1-3), and

the connecting openings (11-16, 17-22) penetrating the foils (1-3) in the area of the electrodes (5-10), and the electrodes (5-10) in each case having a cut-out (23-28) which surrounds either the first (11-16) or the second (17-22) connecting opening,

- stacking a plurality of foils (1-3) one over another so that, in a resulting stacked arrangement, the first and second connecting openings (11-16, 17-22) are arranged one over another,

the layer sequence of the foils (1-3) being selected in such a manner that the connecting openings (11-16, 17-22), which are arranged one over another, are alternately surrounded by a cut-out (23-28) of the electrodes (5-10) only in every other foil layer (1-3) so that the electrodes (5-10) are alternately connected to either the first connecting openings (11-16) or the second connecting openings (17-22),

- introducing an electrically conductive paste (53) into the connecting openings (11-16, 17-22),
- firing the stacked arrangement, and
- separating the stacked arrangement into individual actuators.

2. The method as recited in Claim 1,

characterized in that, on the surfaces (4) of the foils (1-3), intermediate areas (31) which are left free of the electrodes (5-10) are provided in the edge area between the individual actuators.

3. The method as recited in Claim 1 or 2,
characterized in that perforation holes (30) are formed in the intermediate areas (31).
4. The method as recited in Claim 3,
characterized in that the perforation holes (30) are arranged in lines extending in the intermediate areas (31) along the edges of the individual actuators.
5. The method as recited in Claim 3 or 4,
characterized in that, to separate the stacked arrangement into the individual actuators, an oppositely poled electrical field is applied to the electrodes (5-10) of adjacent actuators.
6. The method as recited in one of the Claims 1 through 5,
characterized in that the separation of the stacked arrangement into the individual actuators is carried out by sawing or water-jet cutting.
7. The method as recited in one of the Claims 1 through 6,
characterized in that the stacked arrangement is dried under pressure at an increased temperature prior to the firing.
8. The method as recited in one of the Claims 1 through 7,
characterized in that the electrodes (5-10) are applied using a screen-printing technique, vapor depositing, sputtering, or the like.
9. The method as recited in one of the Claims 1 through 8,
characterized in that the stacked arrangement is sintered during the firing under uniaxial pressure at a temperature of at least 1,000° C.
10. A piezoelectric actuator comprising a plurality of layers (50) made of a piezoelectric ceramic material which are arranged one over another, and which are

each coated with at least one electrode (5) on a surface (4), the electrodes (5) being alternately connected to each other,
characterized in that, in each layer (50), a first and second connecting opening (11, 17) is provided which penetrates the layer (50) in the area of the electrode (5),
that each electrode (5) has a cut-out (23) which surrounds either the first (11) or the second (17) connecting opening,
that the layers (50) are stacked in such a manner that the first and second connecting openings (11, 17) of all layers (50) are arranged one over another, and
the connecting openings (11, 17), which are arranged one over another, are alternately surrounded by a cut-out (23) of the electrodes (5) only in every other layer so that the electrodes (5) are alternately connected to the first connecting openings (11) and the second connecting openings (17), and
that the connecting openings (11, 17) are filled with an electrically conductive paste (53).

11. The piezoelectric actuator as recited in Claim 10,
characterized in that the electrodes (5) are composed of a netlike metal layer.

12. The piezoelectric actuator as recited in Claim 10 or 11,
characterized in that the layers (50) have a peripheral edge area (31) which is not coated with the electrode (5).

13. The piezoelectric actuator as recited in one of the Claims 10 through 12,
characterized in that the outer surface of the topmost and/or bottommost layer and/or the edge area of the actuator is embedded in an electrically insulating encapsulating material.